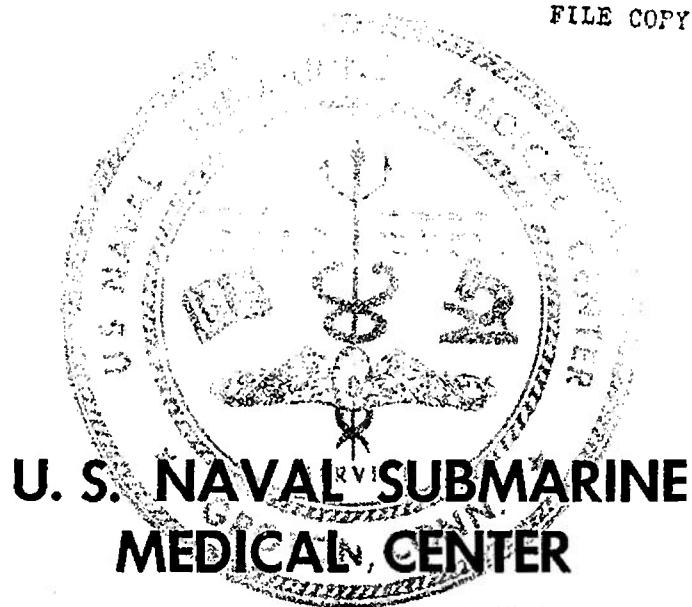


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**SHORT TERM ASSESSMENT OF DENTAL CALCULUS FORMATION RATES  
IN SUBMARINE PERSONNEL**

by

Lieutenant Commander F. E. Isabelle, MC, USN  
and  
Commander W. R. Shiller, DC, USN

Bureau of Medicine and Surgery, Navy Department  
Research Work Unit MR005.20.01-6042B.06

Released by:

James E. Stark, CAPT, MC, USN  
COMMANDING OFFICER  
Naval Submarine Medical Center

18 May 1970



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SUBMARINE MEDICAL RESEARCH LABORATORY  
NAVAL SUBMARINE MEDICAL CENTER REPORT NO. 627

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## SUMMARY PAGE

### THE PROBLEM

To devise methods of longitudinal calculus formation rate assessment which have long been lacking. Ideally, the assessment should be simple to use, be reproducible, and require a short calculus formation rate time. The Marginal Line Calculus Index (MLCI) appeared promising in each of these areas. A field test was required to determine its practical usefulness.

### FINDINGS

Analysis revealed that the MLC Index is simple and reproducible. No statistically significant effects on calculus formation or on its composition were seen as a result of a FBM submarine deployment. No correlation was demonstrated between the MLCI and the Volpe-Manhold Index.

### APPLICATIONS

The lack of FBM environmental effect on calculus formation corroborates the findings of Piebenga and Shiller (13). The MLCI is recommended as a reproducible method for assessment of calculus initiation.

### ADMINISTRATIVE INFORMATION

This investigation was conducted as a part of Bureau of Medicine and Surgery Research Work Unit MR005.20.01-6042B - Study of Preventive Dental Principles and Methods in Military Populations. This report has been designated as Submarine Medical Research Laboratory Report No. 627. It is Report No. 6 on this Work Unit and was approved for publication as of 18 May 1970.

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## ABSTRACT

An attempt was made to determine the usefulness of the Marginal Line Calculus Index (MLCI) as a tool to measure extremely short term calculus formation rates in Fleet Ballistic Missile (FBM) personnel. Fifteen unselected FBM crew member volunteers were used as subjects. Calculus assessments were performed periodically by both the MLCI and by the Volpe-Manhold Index. No significant correlation was found between the two indices. No patrol effects were noted on calculus formation rates or its composition. The reproducibility of MLCI determinations was found to be of a high degree. It is concluded that the MLCI is a useful investigative tool in assessing calculus initiation.

# SHORT TERM ASSESSMENT OF DENTAL CALCULUS FORMATION RATES IN SUBMARINE PERSONNEL

## INTRODUCTION

The relationship between dental calculus and periodontal disease is well established (1, 2, 3, 4, 5). Some relationship between the rate of calculus formation and other systemic conditions has also been reported (6, 7, 8).

Since the amount of calculus on the teeth at any given time is so dependent on the frequency of professional care, cross-sectional surveys are limited in providing knowledge of the really fine relationships between calculus and health. For this reason, as well as for the assessment of calculus inhibitors, longitudinal studies are required.

Methods of longitudinal calculus formation rate assessment have long been meager. Ideally, the assessment method should be simple to use, be reproducible, and require a short calculus formation time period. Of all the measurement methods, only two have seemed suitable to calculus formation rate studies in the Navy; the standardized foil technique (9), and the Volpe-Manhold direct measurement technique (10). Each of these techniques has advantages and each has decided disadvantages (11). The standardized foil technique involves a meticulous attachment of a small Mylar\* foil to the lower anterior teeth for a period of one week. This has proven to be rather clumsy under field conditions. The Volpe-Manhold method is simple but requires at least a two month measurement period.

\*MYLAR (DuPont/TYP A 200), Wilmington, Del.

Recently, a new index has been proposed - the Marginal Line Calculus Index (MLCI)<sup>12</sup>. This index requires a simple direct assessment and a two week collection period. This index could possibly answer the needs of the ongoing and the proposed dental calculus studies in the U. S. Navy. It is therefore proposed that the suitability of this index be evaluated and at the same time the composition of calculus be assessed in FBM submarine personnel prior to and during patrol.

## MATERIALS AND METHODS

Fifteen unselected volunteers were the subjects for this study. Each subject had his teeth scaled and polished by the staff of the Dental Branch, Submarine Medical Research Laboratory, prior to patrol. No additional participation of the subjects was required, with the exception of submitting to the subsequent examinations.

The investigator was instructed in the use of the MLCI by the Dental Branch, Submarine Medical Research Laboratory, prior to patrol. The subject was seated in an upright position, the lingual surfaces of the lower anterior teeth were thoroughly air dried, and the MLCI was computed and recorded. The calculus was then scraped from the test surfaces. The calculus assessment was performed every two weeks.

The Volpe-Manhold index scores were assessed prior to the first MLCI

evaluation. All comparisons between the two indices were performed using the prepatrol MLCI scores.

In order to assess the degree of calcification of the collected material and to relate this to the scores obtained, the calculus scraped from the surfaces was placed in small capsules at each examination period. These samples were saved until the end of the patrol. Analysis on the samples was performed upon return from patrol by the Dental Branch, Submarine Medical Research Laboratory, by previously reported methods (13).

### RESULTS

The data concerning the reproducibility of the method are given in Table

1. In general, the agreement between measurement periods appears to be quite good with the possible exception in the case of the values for tooth #24. Even the values for tooth 24 are not too disparate when it is considered that these means represent percentages of the margin involved and that they are recorded only to the nearest 12.5 per cent. In any event, all correlation coefficients are statistically significant ( $P < .05$ ). One additional note should be made of these data: it is readily apparent that most of the calculus formed on the central incisors during this short time period. In fact, if this index were to be used to evaluate a method for reducing calculus, any effect would be most likely to be discovered in these two teeth alone.

Table 1. Prepatrol Reproducibility Assessments by the Marginal Line Calculus Index (two measurement periods)

| Measurement variable     | N  | First measurement mean | Second measurement mean | r    |
|--------------------------|----|------------------------|-------------------------|------|
| Tooth #23                | 11 | $9.09 \pm 4.57^*$      | $8.55 \pm 4.43$         | +.90 |
| Tooth #24                | 11 | $54.64 \pm 8.25$       | $38.82 \pm 9.21$        | +.83 |
| Tooth #25                | 11 | $43.82 \pm 9.34$       | $38.77 \pm 8.46$        | +.62 |
| Tooth #26                | 11 | $7.95 \pm 4.62$        | $3.45 \pm 3.29$         | +.88 |
| Mean (all four teeth)    | 11 | $28.85 \pm 5.49$       | $22.4 \pm 5.67$         | +.86 |
| Calcium phosphorus ratio | 10 | $1.59 \pm 0.118$       | $1.50 \pm 0.108$        | -.08 |

\*Standard error of the mean.

The calcium phosphorous ratios (w/w) of the calculus removed from the two surfaces after each two weeks collection period indicate a good degree of calcification. These values agree closely with previously reported findings for individuals in normal atmospheres. It is also noted that the variances were extremely low in these ratio values. This fact precluded the need for correlational analyses for these data.

The comparability of the Marginal Line Calculus Index and the Volpe-Manhold Index is depicted in Table 2. There is seen to be a very weak and not statistically significant correlation between these indices.

The patrol effects on calculus formation measured by the Marginal Line Calculus Index are given in Table 3. It is seen that a slight reduction in calculus formation occurred on patrol versus that seen in the prepatrol period. This difference was not statistically significant when analyzed by the *t* test for paired data. There was a high degree of correlation between the prepatrol and the patrol values ( $r_s = +.77$ ); Spearman

Table 2. Comparison of Rates as Assessed by the Marginal Line Calculus Index and the Volpe-Manhold Method

|                     | N | Mean            | Correlation (r) |
|---------------------|---|-----------------|-----------------|
| Marginal line index | 9 | $24.9 \pm 6.49$ |                 |
| Volpe-Manhold       | 9 | $3.5 \pm 0.72$  | +.26            |

rank correlation test). Thus, again a high degree of reproducibility is indicated.

## DISCUSSION AND CONCLUSIONS

The questions to be answered by this study were essentially as follows:

1. What do the measurements by the Marginal Line Calculus Index mean?
2. How reproducible are the measurements?
3. How does this index compare with other indices?

In addition, a practical operational question was asked: Does the closed environment of a submarine result in a changed calculus formation rate or chemical analysis as measured by the Index, and measurement of calcium phosphorous ratios?

It is recognized that this index really measures the rate of initiation of calculus formation. The rather high calcium phosphorous ratios (Table 1) however, do indicate that actual calcified deposits are being considered. These ratios agree closely with those found in individuals in normal atmospheres and in the same individual prior to and during patrol (Table 3). The index, however, is structured so that close agreement with a measurement of amount of calculus formed over a period of time should not be an absolute expectation. The results of this study actually showed such agreement was lacking. It is recognized that many variables such as roughage of the diet and hygiene

Table 3. Patrol Effects on Calculus Formation Rates  
(Marginal Line Calculus Index)

| Subject      | Prepatrol Mean    | Patrol Mean     | Difference (Prepatrol minus patrol) |
|--------------|-------------------|-----------------|-------------------------------------|
| 1            | 19                | 20.6            | - 1.6                               |
| 2            | 32                | 50              | -18.0                               |
| 3            | 0                 | 8               | - 8.0                               |
| 4            | 75                | 12.5            | +62.5                               |
| 5            | 6                 | 12.5            | - 6.5                               |
| 6            | 62.5              | 28.9            | +32.6                               |
| 7            | 6                 | 8               | - 2.0                               |
| 8            | 18.8              | 17              | + 1.8                               |
| 9            | 62.5              | 50              | +12.5                               |
| 10           | 12.5              | 17              | - 4.5                               |
| 11           | 43.8              | 20.6            | +23.2                               |
| 12           | 6                 | 0               | + 6.0                               |
| 13           | 6                 | 0               | + 6.0                               |
| 14           | 6                 | 8               | - 2.0                               |
| 15           | 37                | 41.3            | - 4.3                               |
| Overall mean | $26.2 \pm 6.15^*$ | $19.6 \pm 4.05$ | $+ 6.58 \pm 5.18$                   |

\*Standard error of the mean.

practices could prevent a great building up of calculus deposits, but might have almost no effect on the initial deposits in the sheltered area of the gingival sulcus.

The close agreements between repeated measurements on the same teeth and the same individuals (Table 3) certainly indicate that the Marginal Line Calculus Index is useful from the standpoint of reproducibility. As a matter of fact it is conceivable that this index may be of great use in instances where the effect of diet, hygiene practices, and other factors can not be controlled in a calculus formation study. The initiation of calculus formation in the sheltered gingival sulcus could be a sensitive, relatively uncomplicated test of some physiological mechanisms.

The lack of effect of the FBM environment on calculus formation corroborates the findings of Piebenga and Shiller (13). Actually, both this method of assessment and the one used by Piebenga and Shiller are very similar in that each was based on very short term collection periods. A careful study of long term calculus formation still must be done in the FBM environment in order to clarify this process completely.

In conclusion, the Marginal Line Calculus Index appears to be a useful tool in assessing calculus initiation. Its lack of correlation (Table 2) with the Volpe-Manhold method should not give too much concern, except to strongly point to the need for determining the exact questions to be asked in any *in vivo* calculus study so that the appropriate assessment method may be used.

## REFERENCES

1. Ramfjord, S.P. The periodontal status of boys 11 to 17 years old in Bombay, India. *J. Periodont.* 32:237-248, 1961.
2. Sharawy, A.M., Sabharwal, K., Socransky, S.S. and Lobene, R.R. A quantitative study of plaque and calculus formation in normal and periodontally involved mouths. *J. Periodont.* 37:495-501, 1966.
3. Leung, S.W. The relation of calculus, plaque and food impaction to periodontal disease. *J. Dent. Res.* 41:306-311, 1962.
4. Shiller, W.R. Periodontal health of Submarine School Candidates: A correlative analysis. *J. Periodont.* 37:224-229, 1966.
5. Shiller, W.R. Oral health of operating conventional submarine crews: A cross-sectional survey. *SMRL Memo Rept.* 66-10, 7 April 1966.
6. Manhold, J.H., Volpe, A.R. and Manhold, B.S. Interrelationships between salivary calculus formation blood serum phosphorous level and salivary respiration ( $QO_2$ ). *J. Periodont.* 36:474-477, 1965.
7. Scopp, I.W., Morgan, F.H. and Dooner, J.J. Urinary calculus and salivary calculus. *J. Periodont.* 37:156-157, 1966.
8. Wiener, S.P., Ward, H.L. and Archer, M. The rate of deposit of supragingival calculus as an

indicator of individuals prone to coronary heart disease: A preliminary study. J. Chronic Dis. 17:191-198, 1964.

9. Muhlemann, H.R. and Schroeder, H.E. Dynamics of supragingival calculus formation. Advances in Oral Biology (1), ed. P.H. Staple, New York, Academic Press, 1964, p. 175.

10. Volpe, A.R., Manhold, J.H. and Hazen, S.P. In vivo calculus assessment: Part 1. A method and its examiner reproducibility. J. Periodont. 36:292-298, 1965.

11. Gould, S.S. and Shiller, W.R. Longitudinal study of dental calculus in humans in Antarctica. Submarine Medical Center Report No. 512, 23 Feb 1968.

12. Muhlemann, H.R. and Villa, P.R. The Marginal Line Calculus Index. Helvistica Odontologica Acta 11:175-179, 1967.

13. Piebenga, L.W. and Shiller, W.R. Dental calculus formation rate in a submarine environment. J. Dent. Res. 47(4):613-615, July-Aug 1968.

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